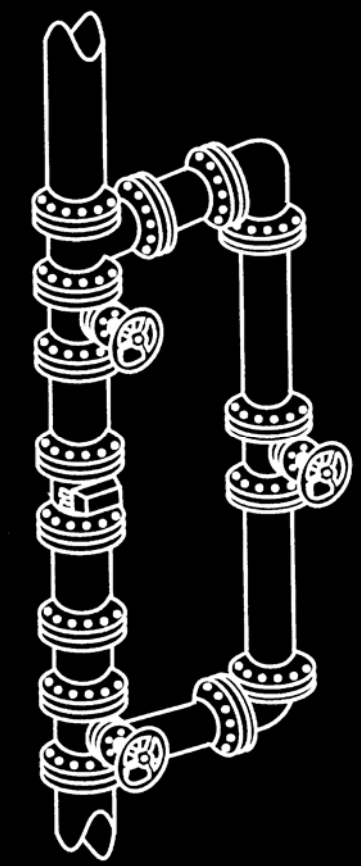
Plant Maintenance Certification

2007-2008

Candidate Handbook

Plant Maintenance Technologist Grade 1
Electrical/Instrumentation Technologist Grades 2-4
Mechanical Technologist Grades 2-4



This booklet contains...

- ✓ Subject matter for the Plant Maintenance tests
- ✓ Education and experience requirements
- ✓ Selected study references
- ✓ Certification policies
- ✓ Frequently Asked Questions

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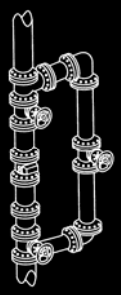

This handbook contains information about the Plant Maintenance certification program. Please read this entire handbook to become familiar with certification procedures and policies. As a certificate applicant, you are responsible for knowing the contents of this handbook. If you have any questions please contact your Local Section Chair (listed in the TCP Application) or the CWEA office at 510-382-7800.

Statement of Non-Discrimination Policy

CWEA does not discriminate among applicants on the basis of age, gender, race, religion, national origin, disability, sexual orientation or marital status.

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Technical Certification Program
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Introduction

The California Water Environment Association
CWEA's mission is to enhance the education and effectiveness of California wastewater professionals through training, certification, dissemination of technical information, and promotion of sound policies to benefit society through protection and enhancement of the water environment.

CWEA is a California Nonprofit Corporation and is a Member Association of the Water Environment Federation and a member of the National Organization for Competency Assurance.

The Technical Certification Program
The Technical Certification Program (TCP) was created to offer multilevel technical certification for individuals employed in the water quality field. Tests are written by vocational specialists and administered twice yearly in six different disciplines: Collection System Maintenance, Environmental Compliance Inspection, Laboratory Analyst, Plant Maintenance (Electrical/Instrumentation and Mechanical Technologist), Biosolids and Industrial Waste Treatment Plant Operator.

CWEA first offered a certification program for operators of wastewater treatment plants in 1937. The program was administered by CWEA until 1973 when the State of California assumed responsibility for the program. During those 36 years, CWEA awarded 3915 operator certificates.

In 1975 the first committees were formed to establish a new voluntary certification program for water quality professionals specializing in disciplines other than plant operation. Eventually, the Voluntary Certification Program (VCP) emerged with specialized certificate programs for Collection System Maintenance, Plant Maintenance, Environmental Compliance Inspector, and Laboratory Analyst. The first of the new certifications were given in April of 1976. In the 1980s two more disciplines were added: Electrical/Instrumentation, and Industrial Waste Treatment Plant Operator.

Today CWEA offers certification in six different vocational programs with a total of 23 different certifications. About 1600 certification applications are processed every year and over 4000 certificates are currently held by individuals in California, Michigan, Hawaii, Missouri and Alaska.

The Certification Process
To become certified, ***all applicants*** must complete the Application For Technical Certification, pay the application fee, have appropriate experience and education, and pass the written test. Application instructions and fee schedules are listed on the application. After applications are received at the CWEA office, applicant information is compiled in the certification database.

Important Information

Receipts are then mailed to all applicants. The application is then reviewed by CWEA staff. Next, the applications are reviewed by TCP Local Section Chairs. If the application is approved, then the applicant will receive a confirmation letter giving test site information. If the application is rejected, the applicant will be notified and may be asked to supply more information if warranted. After completing the written test, applicants are sent results. Those who pass will receive certificates and wallet cards.

Code of Ethics
The Code of Ethics is intended to reflect the standards and behavior that California Water Environment Association certificate holders and applicants expect of each other as they perform their work protecting public health and the environment and that reaffirm the value of holding a CWEA certificate. The purpose of the Code of Ethics is to ensure public confidence in the integrity and service of professional water quality workers while performing their duties.
All California Water Environment Association certificate holders and applicants are expected to meet the following standards of professional conduct and ethics:

1. To protect public health, themselves, their co-workers, property, and the environment by performing the Essential Duties of the CWEA certified vocation safely and effectively, and complying with all applicable federal, state and local regulations.
2. To represent themselves truthfully and honestly throughout the entire certification process.
3. To adhere to all test site rules and make no attempt to complete the test dishonestly or to assist any other person in doing so.
4 To refrain from activities that may jeopardize the integrity of the Technical Certification Program.

Test Administration And Admission
Testing Dates and Sites: Tests are given twice each year on the fourth Saturday of January and July (see Application for Technical Certification for test schedule and test site map). Applicants who are eligible for the test will be mailed a confirmation letter and map to their test site. Reasonable accommodations can be made for those who cannot take the test on Saturdays because of religious reasons by contacting the CWEA office at 510-382-7800. CWEA also provides reasonable accommodations for those with physical or learning disabilities (See following page: "Accommodations For Those With Physical or Learning Disabilities").

Test Site Admission: Certificate candidates are required to show at least one valid government issued photo identification (State driver's license or ID, or passport). Only after positive identification has been made by the proctor may a candidate's test booklet be distributed. Candidates are not required to show their confirmation letters

to enter the test site.

Test Security: All tests are closed-book. No reference material, cell phones, palm pilots, PDAs, programmable calculators, computers, or cameras are allowed in the test site. Candidates should only bring a scientific calculator and a few #2, or softer, pencils. All writing and notes must be in the test booklet. Candidates are not allowed to take any notes from the test site. Candidates who violate test site rules may be asked to leave the site and may be disqualified from that test. All violations of test security will be investigated by CWEA and appropriate action will be taken.

Test Design And Format

Test Design: All certification tests are designed to test knowledge and abilities required to perform *Essential Duties* with minimal acceptable competence.

The *Essential Duties* and *Test Content Areas* for each certification were determined by a job analysis and *meta-analysis* of job specifications by two independent psychometric consulting firms. The studies gathered data from on-site visits of over 31 water and wastewater agencies, interviews with 110 water and wastewater professionals, and analysis of more than 300 job specifications. All research was conducted under the guidance of the Technical Certification Program Committee, vocational sub-committees, and CWEA staff. All test questions are designed to measure at least one area of knowledge or ability that is required to perform an essential duty.

Test Delivery Mechanism: All tests are given in a test booklet with a separate form for marking answers. Tests are written in the English language only.

Test Format: All Plant Maintenance tests are given completely in the multiple choice format (see *Sample Test Questions* in this booklet for an example). The multiple choice format is considered the most effective for use in standardized tests. This objective format allows a greater coverage in content for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Test Scoring

Scoring Method: All tests are mechanically scored by CWEA. The overall test score will determine if you pass or fail the test. The minimum passing score depends on the difficulty level of the test and is determined by the Modified Angoff Method. More difficult tests will have a lower passing score and less difficult tests will have a higher passing score. The minimum passing score is 75% of items answered correctly. However, the score may be adjusted downward depending on the difficulty level of the test. The exact passing score is determined after the test is administered.

How Passing Scores Are Set: Each time a certification test is given, the questions are changed, resulting in a different test form. Since each form has different questions the difficulty level of the test may not be the same from form to form. The passing score is developed as an overall estimate of minimal acceptable competence in the Test Content Areas by subject matter and testing experts. Passing scores are determined by an overall passing score, not by performance on individual Test Subject Areas, and are independent of other candidate's scores. Partial credit will not be awarded for any test item answered incorrectly.

Test Postponement and Cancellation Instructions

To postpone your application you must submit a signed written request (a letter stating that you wish to postpone), with a $35 administrative fee. The written request and payment must be received at the CWEA office no later than six (6) days after the scheduled test date. You may only postpone your application twice. There are no exceptions to this policy.

To cancel your application you must submit a signed written request (a letter stating you wish to cancel your application) to CWEA. The written request must be received at the CWEA office no later than six (6) days after the scheduled test date. Full refunds, less a $35 administrative fee, will be made within 4 weeks after the scheduled date. There are no exceptions to this policy.

Item Appeals

Candidates who wish to appeal a specific test item must do so during the test by completing an Item Appeal form available from the test proctor. Item appeals will be evaluated and appropriate adjustments made during the scoring process.

Test Result Notification

Exam results are routinely mailed to certificate candidates approximately 4 weeks after the exam date. No results are given by phone, fax or email. All results are confidential and are only released to the certificate candidate.

Issue of Certificate

Certificates will be issued to all candidates who pass the exam. Certificates are mailed about two to three weeks after result notifications have been mailed.

Renewal of Certification

All certificates must be renewed annually. The first renewal is due one year from the last day of the month in which the certification exam was held. Certificate renewals less than one year past due are subject to the renewal fee plus a penalty fee. Certificates more than one year past due are not renewable. Re-testing is required to reinstate certificates more than one year past due. Renewal notices are mailed to certificate holders two

months before the due date.
It is the responsibility of the certificate holder to ensure that his or her certificate(s) remains valid. Continuing education will be required for renewal after July 2002.

Re-Certification: CWEA Certificate holders shall be required to renew certificates annually, and shall be required to provide evidence of completion of 12 contact hours of continuing education requirements every two years. For more information, visit CWEA's website: www.cwea.org.

Accommodations For Those With Physical or Learning Disabilities

In compliance with the Americans with Disabilities Act, reasonable accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect the individual's ability to successfully complete the certification exam. Written requests for reasonable accommodations must be made no later than 3 weeks before the exam date.

Program Structure

Background:

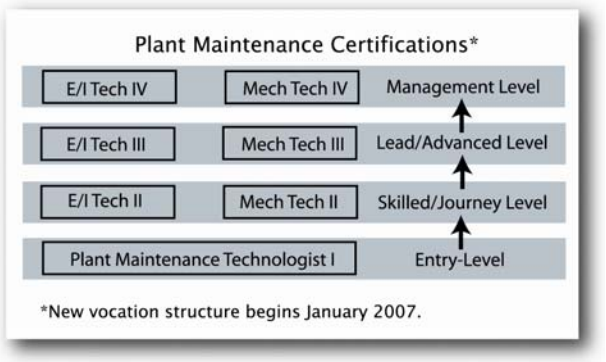
The Plant Maintenance Certificate Program combines the Electrical/Instrumentation Technologist and Mechanical Technologist vocations at the entry level. Grade I certificate candidates are expected to have basic technical knowledge of both vocations.

Plant Maintenance Grade levels II, III and IV are composed of separate Electrical/Instrumentation and Mechanical Technologist certifications. The level of technical expertise at these levels are more specialized than at the Grade I level.

The Plant Maintenance Program structure is based on the same research and job analyses that are the basis of the test design. After analyzing job specifications at many agencies, and working with the feedback from professionals in the field, it was determined that the Electrical/Instrumentation and Mechanical Technologist certifications should be merged into a single Plant Maintenance occupational group at the entry level.

Hierarchical Levels:

The figure to the right diagrams the program structure. At the entry level is Plant Maintenance Grade I. This entry level certification is designed to measure competence as a general plant maintenance worker. Grade I Plant Maintenance Technologists are expected to be able to assist either mechanical maintenance or electrical/ instrumentation specialists performing fundamental duties. Certificate candidates should be familiar with the basic mechanical and electrical/instrumentation principles and duties listed in the *Grade I Plant Maintenance Technologist* section of this handbook.



Grade II and III are specialist levels. Candidates may choose to demonstrate competency in either electrical/instrumentation, mechanical technology, or both. At these levels candidates are expected to have a wide range of knowledge within their specialty. Many candidates find that the scope of knowledge required for successful completion of the test is beyond that utilized on a daily basis at their own workplace. Certificate holders are expected to demonstrate a wide range of knowledge, skills, and abilities because they should be able to perform the essential duties of mechanical technologists or electric/ instrumentation technologists at any water quality agency.

Grade IV certification is designed for managerial level personnel involved with electrical/ instrumentation or mechanical technology. Certified individuals at this level are expected to demonstrate competency as managers of plant maintenance operations. Qualified candidates should be able to demonstrate the managerial functions, as outlined in the *Grade IV Electrical/ Instrumentation* or *Grade IV Mechanical Technologist* sections of this handbook as well as the ability to understand and make managerial level decisions regarding electrical/instrumentation or mechanical technology issues.

Vocation Split for Grade IV

Splitting the Plant Maintenance Grade IV certification into two specialties allows more in-depth technical content to be tested. The last test for the Plant Maintenance Grade IV was given July 2006. Test takers can expect the same subject areas as the Plant Maintenance Grade IV, but with more emphasis on the technical content for each specialty.

Existing Plant Maintenance Grade IV certifications will remain valid as long as the annual renewal fees are paid and the contact hour requirement is still met. Individuals holding a Plant Maintenance Grade IV must take the new test to become certified as a Grade IV Mechanical or Electrical/Instrumentation Technologist.

Grade I Plant Maintenance Technologist

Plant Maintenance Grade I Certification is designed to demonstrate competency at the entry and basic working level. More specifically, Grade I certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of an entry level Plant Maintenance Technologist.

Eligibility Criteria For Taking The Test

There are no experience or education requirements for Grade I certification. Completing the Application for Technical Certification, paying the appropriate application fee, and passing the exam are the only requirements. It is, however, *recommended* that Grade I candidates have at least one year of experience working as a Plant Maintenance Technologist performing the *Essential Duties* listed below. Many candidates without the recommended experience have difficulty successfully completing the written test.

Essential Duties Of The Grade I Plant Maintenance Technologist

Individuals certified as Grade I Plant Maintenance Technologists are expected to possess acceptable competency when performing the tasks that are necessary for entry level Plant Maintenance Technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade I

101. Interprets and works from basic drawings, designs, schematics, sketches, and written and verbal instructions; performs basic maintenance, repairs, fabrication, and rebuilding of shop, field and plant equipment used in water and/or wastewater treatment facilities, pump stations, and collection systems
102. Lubricates, adjusts, and maintains shop, field, and plant equipment, including inspection, cleaning, and repairing wet wells, pipelines, pumps, compressors, valves, chemical feed, and processing equipment
103. Performs basic preventive and corrective maintenance by isolating power, grounding wires, troubleshooting problems, making repairs, restoring power and checking for proper operation
104. Performs basic electrical and instrumentation circuit installation for additions or modifications by bending and installing conduit, pulling wire, wiring in circuits as shown on blueprint and testing system for proper installation
105. Assists in the installation of, inspection, and repair of a variety of pumps, such as centrifugal, positive displacement, and screw; services, lubricates, adjusts, and maintains pumps; removes and installs packing and most seals
106. Using basic welding skills to perform horizontal welding and fabricating with acetylene and arc welders; heats and cuts materials; and fabricates simple projects
107. Maintains, installs, inspects, and repairs piping systems of galvanized, PVC, stainless steel, and copper tubing; identifies types of piping, fittings, and basic valves; cuts and threads pipes; and makes minor modifications to existing piping systems
108. Performs basic to routine maintenance and repair tasks on engines, such as changes oil, belts, and spark plugs; replaces filters; obtains oil and fuel samples; and takes hydrometer readings of coolant and battery fluids
109. Performs regularly scheduled maintenance, inspection, and repair tasks on comminuting and grinding devices; replaces and adjusts cutters and combs; cleans bar screens; lubricates devices; and assists others in the more complex repairs
110. Performs basic maintenance, inspection, and repair tasks on mechanical and electrical drive components
110. Maintains, inspects, and repairs a variety of hydraulic, pneumatic and electrical process control equipment
112. Follows the safe and proper use of various hand, power tools and test instruments
113. Follow proper safety practices, precautions, and procedures, such as confined space entry, storing, handling, and transporting gases, using correct lockout and tagout procedures; and assisting in rigging as required for the movement or placement of heavy machinery or equipment
114. Complete minimal work process documentation

Complexity Of Test Questions
At the Grade I level, certificate candidates are expected to have basic knowledge of the job and the ability to safely perform the *Essential Duties*. Examinees will have to answer multiple choice questions that test knowledge, comprehension, and application of the subject matter. The complexity of the questions will range from basic recall of previously learned material and the ability to understand the meaning of the subject matter, to being able to apply knowledge to new situations.

Test Content Areas
The following list is an outline of *Test Content Areas*. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties* listed above. Since all of the Knowledge, Skills, or Abilities are required to perform the *Essential Duties* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are equally weighted on the test.

Test Content Areas For Grade I

Knowledge of:

101. Methods, practices, procedures, and tools for general equipment repair and maintenance

102. Safety precautions pertaining to working in a plant maintenance environment

Skill to:

103. Establish and maintain effective working relationships

104. Use standard hand, electric, and pneumatic tools and equipment of the plant maintenance trade

105. Communicate clearly and concisely, both orally and in writing, in the English language

Ability to:

106. Perform entry level maintenance and repair of construction, shop, field, and plant equipment and structures

107. Interpret basic plant drawings, specifications, diagrams and schematics, record and keep standard and computerized records

108. Perform shop mathematics

109. Work in an environment that requires logical reasoning in the diagnosing and troubleshooting of equipment and controls

Grade II PM Mechanical Technologist

Plant Maintenance (PM) Mechanical Technologist Grade II Certification is designed to demonstrate competency at the skilled or journey level. More specifically, Grade II certification implies competence in the knowledge, skills, and abilities required to perform the *Essential Duties* of a skilled Mechanical Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is four years of full-time work experience performing the *Essential Duties* of a Grade II Mechanical Technologist (listed below). You may also qualify by having two years of experience and holding a Plant Maintenance or Mechanical Technologist Grade I Certificate for one year, **OR** having two years of full-time experience and holding an Associate's degree in a related field, **OR** having one year of full-time experience and holding a Bachelor's, or higher, degree in a related field.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination **A**, **B**, **C**, or **D**. If you do not meet any of the combinations of experience and education, then you do not qualify for Grade II:

Combination	EDUCATION & CERTIFICATIONS	+ EXPERIENCE
A	None	4 full-time years in vocation*
B	Grade I PM or Mechanical Technologist Certificate for 1 year	2 full-time years in vocation*
C	AA/AS degree in a related field	2 full-time years in vocation*
D	Hold a BA/BS, or higher, degree in a related field	1 full-time year in vocation*

* experience must be in mechanical technology or other field closely related to water or wastewater plant mechanical maintenance.

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties Of The Grade II PM Mechanical Technologist

Individuals certified as Grade II PM Mechanical Technologists are expected to possess acceptable competency when performing the tasks that are necessary for skilled or journey level Mechanical Technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade II

201. Essential duties identified on the Test Content Specifications for Plant Maintenance Grade I
202. Repairs, maintains, installs, inspects, troubleshoots, and adjusts a variety of mechanical equipment at treatment facilities Equipment includes: sluice gates, compressors, and flights; hydraulic controls; mechanical, structural, and plumbing apparatus; belt, chain, and conveyors; diesel and/or gas engines and related co-generation equipment
203. Using work orders, drawings, specifications, schematics, sketches, verbal and written instructions, performs complex mechanical maintenance, repairs, fabrication, and rebuilding of shop, field, and plant equipment used in wastewater plants, pump stations, and collection systems
204. Maintains, installs, inspects, and repairs a variety of pumps, such as centrifugal, positive displacement, and screw; services, lubricates, and adjusts chemical feed and processing equipment; determines excess wear and pump efficiencies; and follows preventive and predictive maintenance practices
205. Performs horizontal and vertical welding, fabricating, silver soldering, hard facing, and brazing using acetylene, arc, mig, and tig welder on most ferrous and nonferrous metals; makes specialized cuts and complex angles using a band saw; and performs blacksmithing and parts fabrication
206. Maintains, installs, inspects, and repairs piping systems of PVC, black and cast iron, stainless steel, and copper tubing; installs, removes, and repairs larger pipes and valves; draws minor new designs; modifies

existing piping systems and welded steel pipe, such as nozzles and saddles; and taps, cuts, and threads pipes

207. Performs complex maintenance and repair tasks on a wide variety of internal combustion engines; adjusts valves and carburetors; and repairs and maintains exhaust systems

208. Performs regularly scheduled maintenance, inspection, and repair tasks on comminuting and grinding devices; overhauls equipment, such as cutters, bearings, chains, mechanical seals, gear reducers; performs close tolerance checking and testing

209. Performs basic to complex maintenance, inspection, and repair or overhauling tasks on drive components, such as right angle drive gears, reduction drives, variable speed and belt and chain drives

210. Overhauls, maintains, installs, adjusts, inspects, and repairs a variety of hydraulic and pneumatic systems and compressors

211. Properly uses and cares for hand and power tools such as grinders, saws, jacks, hydraulic presses and pullers, and pipe threaders, inspects, tests, and measures equipment and material using precision instruments such as scales, height and depth gauges, calipers, verniers, and micrometers of various types

212. Plans tasks, keeps records of work performed and makes estimates of labor and material necessary for the performance of the work

213. Follows proper safety practices, precautions, and procedures, such as confined space entry, storing, handling, and transporting gases, using correct lockout and tagout procedures, using flash protection when welding, and assisting in using safe rigging and welding practices

Complexity Of Test Questions

At the Grade II level, certificate candidates are expected to have the knowledge, skill and ability to safely and effectively accomplish most of the *Essential Duties* listed above. Grade II candidates are also expected to be familiar with the Grade I Test Content Areas. Examinees will have to answer multiple choice questions that test comprehension, application and analysis of the subject matter. The complexity of the questions will cover the ability to basically understand the subject matter; to recall and apply principles, ideas, and theories; and to break down ideas and theories into their constituent parts.

Test Content Areas

The following list is an outline of Test Content Areas. Each content area is a knowledge, skill, or ability that is required to perform the *Essential Duties* listed above. Since all of the knowledge, skills, or abilities are required to perform the *Essential Duties* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are equally weighted on the test. Candidates should also be thoroughly familiar with the Grade I Plant Maintenance Technologist *Test Content Areas*.

Test Content Areas for Grade II

201. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I

Knowledge of:

202. Standard methods, theory, practices, materials, tools, and equipment used in installing, adjusting, maintaining, and repairing mechanical equipment common to a wastewater treatment plant and collection system

203. Safety practices and procedures pertaining to the work performed

204. Characteristics and capabilities of common metals and alloys; uses and operation of electric and gas cutting and welding equipment; rigging principles and techniques

Skill to:

205. Use standard hand, electric, and pneumatic tools and equipment of the mechanical trades

206. Establish and maintain effective working relationships

Ability to:

207. Interpret mechanical drawings, plans, and specifications

208. Diagnose and troubleshoot a variety of mechanical equipment common to a water quality facility

209. Make repairs and perform routine preventive/predictive maintenance to the equipment used in the collection, transport, and treatment of wastewater

210. Estimate labor and materials for proposed work and keep and complete records

211. Effectively communicate in both written and oral form, in the English language

212. Provide training to maintenance personnel

Grade III PM Mechanical Technologist

Plant Maintenance (PM) Mechanical Technologist Grade III Certification is designed to demonstrate competency at the lead or advanced technical level. More specifically, Grade III certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of a lead or advanced Mechanical Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is six years of full-time work experience performing the *Essential Duties* of a Grade III Mechanical Technologist (listed below). You may also qualify by having four years of experience and holding any Grade II Plant Maintenance Certificate for two years, **OR** having four years of full-time experience and holding an Associate's degree in a related field, **OR** having three years of full-time experience and holding a Bachelor's, or higher, degree in a related field.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination **A**, **B**, **C**, or **D**. If you do not meet any of the combinations of experience and education, then you do not qualify for Grade III:

Combination	EDUCATION & CERTIFICATIONS	+ EXPERIENCE
A	None	6 full-time years in vocation*
B	Hold Grade II Plant Maintenance Certificate for 2 years	4 full-time years in vocation*
C	Hold an Associate's degree in a related field	4 full-time years in vocation
D	Hold a BA/BS, or higher, degree in a related field	3 full-time years in vocation*

* experience must be in mechanical technology or other field closely related to water or wastewater plant mechanical maintenance.

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties

Individuals certified as Grade III PM Mechanical Technologists are expected to possess acceptable competency when performing the tasks that are necessary for lead or advanced level Mechanical Technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade III

301. Essential duties identified on the Test Content Specifications for Plant Maintenance Grade I, and Mechanical Technology Grade II
302. Prepares, receives and reviews assignments for the mechanical maintenance of potable water, wastewater, storm drainage, hydraulic power, chemical handling systems and oxygen injection systems
303. Supervises and participates in and reviews the work of staff responsible for maintenance of the wastewater treatment plant including repair and installation of all hydraulic, pneumatic and mechanical equipment
304. Participates in the development of policies and procedures; monitors work activities to ensure compliance with established policies and procedures and makes recommendations for changes and improvements to existing policies and procedures
305 Performs complex preventive mechanical maintenance
306. Performs complex corrective mechanical maintenance by troubleshooting cause of malfunction using visual inspection and precision measuring and testing instruments and replacing or repairing broken parts such as gauges, gaskets, plugs, coils, wires, bearings, drive lines, valves, pistons, rings, crankshafts and pumps
307. Rebuilds equipment by disassembling, cleaning, ordering replacement parts, repairing mechanical malfunctions and reassembling and testing
308. Plans or assists in the planning and implementation of computer based maintenance programs
309. Estimates materials, equipment, and

personnel necessary for scheduled and emergency repairs and maintenance

310. Prepares and is responsible for time and equipment reports

311 Trains personnel in the proper operation of tools and equipment, chlorine and confined space procedures, and safety practices

312. Responsible for adherence to safety orders and compliance with federal and OSHA regulations in all aspects of work

313. Inspects work in progress and upon completion

314 Establishes standby lists to insure that personnel are available for problems which might occur after work hours, on weekends, and holidays

315. Coordinates work with other departments or agencies

316. Responsible for the administration of outside contract work

317. Assists in the planning, developing and implementing safety and training programs

Complexity Of Test Questions

At the Grade III level, certificate candidates are expected to have the knowledge, skill and ability to safely and effectively accomplish and coordinate complex tasks as listed in the *Essential Duties* above. Grade III candidates are also expected to be familiar with the Grade I Plant Maintenance and Grade II Mechanical Technologist knowledge, skills and abilities. Examinees will have to answer multiple choice questions that test application, analysis, and synthesis of the subject matter. The complexity of the questions will cover the abilities: to abstract in particular and concrete situations; to clarify and organize theories and ideas; and to put facts together to form new solutions.

Test Content Areas

The following list is an outline of Test Content Areas. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties* listed above. Since all of the Knowledge, Skills, or Abilities are required to perform the *Essential Duties* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are equally weighted on the test. Candidates should also be thoroughly familiar with the Grade I Plant Maintenance and Grade II Mechanical Technologist *Test Content Areas*.

Test Content Areas Grade III

301. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I, and Mechanical Technology Grade II

302. The operations, theory, methods, materials, tools, equipment, and safety practices involved in maintenance, construction and repair of mechanical components of potable water quality and storm drainage systems

303. Supervisory principles and practices including training, planning and scheduling work, efficient use of personnel, equipment and materials

304 Methods and techniques of metal fabrication

305. Methods and techniques of handling and transporting hazardous waste and materials, chemicals and gases

306. Pertinent federal, state and local laws, codes and regulations

307. Interpret and explain policies, safety practices and standard operational procedures

308. Respond to and maintain order in emergency situations

309. Communicate clearly and concisely, both orally and in writing, in the English language

310. Establish and maintain effective working relationships

311. Handle public contacts with tact and diplomacy

312 Supervise, organize and review the work of staff

313. Hire, supervise, train and evaluate staff

314. Troubleshoot and maintain plant equipment, machinery and related facilities used in predictive and maintenance equipment as necessary

315. Interpret computer maintenance program printouts and determine proper course of action

316. Read and interpret blueprints, specifications, maps, technical instructions, and information

317. Keep records and prepare reports

Grade IV Mechanical Technologist

Mechanical Technologist Grade IV Certification is designed to demonstrate competency at the program manager level. More specifically, Grade IV certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of a management level Mechanical Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is eight years of full-time work in Plant Maintenance (Electrical/Instrumentation). You may also qualify by having six years of experience and holding an Electrical/Instrumentation Technologist Grade III Certificate for two years, **OR** having six years of full-time experience and holding an Associate's degree in a related field, **OR** having five years of full-time experience and holding a Bachelor's, or higher, degree in a related field. All Grade IV candidates must also demonstrate at least one year of experience supervising the work of others.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination A, B, C, or D. If you do not meet any of the combinations of experience and

Combination	EDUCATION &	+ EXPERIENCE
A	None	8 years in vocation* with one of those years supervising others
B	2 years holding Grade III Electrical/ Instrumentation Technologist certificate	6 years in vocation* with one of those years supervising others
C	Hold an AA/AS, or higher, degree in a related field	6 years in vocation* with one of those years supervising others
D	Hold a Bachelor's, or higher, degree in a related field	5 years in vocation* with one of those years supervising others

* experience must be in electrical/instrumentation technology or other field closely related to water quality or wastewater plant maintenance.

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation, you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties

Individuals certified as Grade IV Mechanical Technologists are expected to possess acceptable competency when performing the tasks that are necessary for management level mechanical technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade IV

401. Essential duties identified on the Test Content Specifications for Plant Maintenance Grade I, and Mechanical Technologist Grade II and III
402. Initiates, plans, directs and oversees the sequence of operations for large and complex repair, maintenance and construction work at treatment plants, pump stations, storm drainage stations, potable and other associated water systems, chemical handling systems and oxygen injection systems
403. Coordinates staffing with operational and mechanical activities, directs the coordination of assigned work with appropriate personnel, reviews, preliminary design and specification, and in association with appropriate staff, makes recommendations involving modifications to facilities
404. Directs, coordinates and reviews the work plan for assigned plant facility services and activities; assigns work activities and projects, monitors work flow; reviews and evaluates work products, methods and procedures; and meets with staff to identify and resolve problems
405. Establishes policies and procedures for operation and maintenance of complex treatment equipment, chemical handling systems and oxygen injection
406. Designs and implements training of crews in plant maintenance, construction, repair and safety principles to meet and comply with national, federal, state, and local regulations
407. Schedules and directs computer based maintenance programs

408. Formulates, initiates and directs the operational parameters for facilities and equipment under manager's jurisdiction, including storm periods or emergencies
409. Approves time sheets, equipment, labor changes and assigns priority of work orders for plant maintenance personnel
410. Participates in the development and implementation of goals, objectives, policies and priorities
411. Selects, trains, motivates and evaluates personnel performance; implements discipline and termination procedures, when required
412. Prepares and presents staff reports and other correspondence as appropriate and necessary
413. Designs and administers safety programs

Complexity Of Test Questions

At the Grade IV level, certificate candidates are expected to have the knowledge, skill and ability to administer, coordinate and manage complex programs described in the *Essential Duties* above. Grade IV candidates are also expected to be familiar with the Grade I, II, and III Plant Maintenance Technologist knowledge, skills and abilities. Examinees will have to answer multiple choice questions that test analysis, synthesis and evaluation of the subject matter. The complexity of the questions will cover the ability: to clarify and organize theories and ideas; to put together facts to form new solutions; to make managerial level judgments.

Test Content Areas

The following list is an outline of *Test Content Areas*. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties* listed above. Since all of the Knowledge, Skills, or Abilities are required to perform the *Essential Duties,* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are approximately equally weighted on the test. Grade IV candidates will not be expected to demonstrate competency in all of the technical aspects of Plant Maintenance Grade I, and Electrical/ Instrumentation and Mechanical Technologist Grade II and III. However it is expected that Grade IV candidates will be familiar enough with the *Essential Duties* and Test Content Areas of these lower grade level Plant Maintenance vocations to make informed management decisions.

Test Content Areas for Mechanical Technologist Grade IV

400. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I, and Mechanical Technologist Grades II and III

Knowledge of:

401. The methods, materials, equipment and chemicals used in the maintenance, repair and construction of various types of mechanical, hydraulic, pneumatic, chemical, and electrical/instrumentation components in water quality treatment plants, complex pumping stations, potable water facilities, and chemical handling
402. Safety principles and state-OSHA NFPA (National Fire Protection Association) 70E and federal, state and local safety order requirements involved in all aspects of plant maintenance work, equipment usage, and confined space work performed
403. Leadership, supervisory principles and practices that include training, planning, budgeting and scheduling effective use of personnel, equipment and materials
404. Computer systems relevant to water quality treatment facilities
405. Pertinent federal, state and local laws, codes and regulations
406. Permit and regulatory requirements for the operation of a water quality facility
407. Principles of budget preparation and control

Skill to:

408. Establish and maintain effective working relationships with those contacted in the course of work, including a variety of government officials and the general public
409. Direct operations of all mechanical, hydraulic, pneumatic, and electrical and instrumentation equipment used in treatment plant operations
410. Communicate clearly and concisely, both orally and in writing in the English language

Ability to:

411. Supervise/direct/coordinate the work of staff
412. Hire, supervise, train and evaluate staff.
413. Interpret and explain applicable policies and procedures
414. Prepare clear and concise reports
415. Plan and oversee complex jobs, including the utilization of personnel, materials, and equipment
416. Interpret and explain blueprints, specifications, and maps
417. Prepare and communicate budget information.
418. Maintain facility to meet permit and regulatory requirements

Grade II PM Electrical/Instrumentation (E/I)

Plant Maintenance (PM) Electrical/Instrumentation Technologist Grade II Certification is designed to demonstrate competency at the skilled or journey level. More specifically, Grade II certification implies competence in the knowledge, skills, and abilities required to perform the *Essential Duties* of a skilled Electrical/Instrumentation Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is four years of full-time work experience performing the *Essential Duties* of a Grade II Electrical/Instrumentation Technologist (listed below). You may also qualify by having two years of experience and holding a Plant Maintenance or E/I Technologist Grade I Certificate for one year, **OR** having two years of full-time experience and holding an Associate's degree in a related field, **OR** having one year of full-time experience and holding a Bachelor's, or higher, degree in a related field.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination **A**, **B**, **C**, or **D**. If you do not meet any of the combinations of experience and education, then you do not qualify for Grade II:

Combination	EDUCATION & CERTIFICATIONS +	EXPERIENCE
A	None	4 full-time years in vocation*
B	Grade I PM or Mechanical Technologist Certificate for 1 year	2 full-time years in vocation*
C	AA/AS degree in a related field	2 full-time years in vocation*
D	Hold a BA/BS, or higher, degree in a related field	1 full-time year in vocation*

* experience must be in electrical/instrumentation technology, or other field closely related to water or wastewater plant electrical/instrumentation maintenance.

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties

Individuals certified as Grade II PM Electrical/ Instrumentation Technologists are expected to possess acceptable competency when performing the tasks that are necessary for lead or advanced level Electrical/Instrumentation Technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade II

201. Essential duties identified on the Test Content Specifications for Plant Maintenance Grade I
202. Performs common preventive maintenance by inspecting equipment, checking voltage and amperage, tightening and cleaning equipment and locating potential problems
203. Performs common preventive and corrective maintenance by isolating power, grounding wires, troubleshooting problems, making repairs, restoring power and checking for proper operation
204. Performs common electrical and instrumentation circuit installation for additions of modifications by bending and installing conduit, pulling wire, wiring in circuit as shown on blueprints and testing system for proper installation
205. Maintains and repairs electrical and instrumentation equipment facilities such as motors, generators, switch-gears, substations and control equipment
206. Tests, adjusts, modifies and maintains analog, digital and logic circuitry, microprocessor controlled devices, elements and components such as programmable logic controllers, process control equipment, telemetering devices, recorders, sensors, and controllers on water and/or wastewater treatment process instruments and devices
207. Prepares purchase requests for parts and materials and contacts vendors for pricing of specialized parts and services
208. Generates power at pump stations during outages by connecting emergency generator to pump stations
209. Establish and maintain effective working relationships

Complexity Of Test Questions
At the Grade II level, certificate candidates are expected to have the knowledge, skill and ability to safely and effectively accomplish most of the *Essential Duties* listed above. Grade II candidates are also expected to be familiar with the Grade I Test Content Areas. Examinees will have to answer multiple choice questions that test comprehension, application and analysis of the subject matter. The complexity of the questions will cover the ability to basically understand the subject matter; to recall and apply principles, ideas, and theories; and to break down ideas and theories into their constituent parts.

Test Content Areas
The following list is an outline of Test Content Areas. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties*. Approximate weightings for some Test Content Areas are given in parenthesis. These reflect the approximate allocation of points on the test. Candidates should also be thoroughly familiar with the Grade I Plant Maintenance *Test Content Areas*.

Test Content Areas Grade II

201. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I

Knowledge of:

202. Electrical and instrumentation principles, methods, tools, equipment and safety procedures
203. Safe and proper use of various hand and power tools, test meters and equipment to troubleshoot, repair, adjust and perform preventive maintenance on electronic process controls and measurement systems, instrumentation systems, electronic meters, programmable controllers and related equipment

Skill to:

204. Communicate effectively both orally and in writing, in the English language
205. Establish and maintain cooperative working relationships

Ability to:

206. Use electrical and instrumentation test equipment and record data regarding electrical/electronic equipment **(15%)**
207. Read and interpret computer logic diagrams, programming guides, electrical drawings, control loop diagrams, schematics, blue prints, maintenance manuals, technical bulletins, ladder diagrams, troubleshooting guides and preventive maintenance instructions **(20%)**
208. Diagnose, repair and calibrate defective electrical, electronic components **(20%)**
209. Design basic electrical and instrumentation controls **(10%)**
210. Troubleshoot electrical, electronic, mechanical, pneumatic, hydraulic, digital and analog control equipment and systems **(20%)**
211. Generate accurate and effective maintenance records, status reports, data and maintenance logs and effectively respond to oral directions and requests

Grade III PM Electrical/Instrumentation

Plant Maintenance (PM) Electrical/Instrumentation Technologist Grade III Certification is designed to demonstrate competency at the lead or advanced technical level. More specifically, Grade III certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of a lead or advanced Electrical/ Instrumentation Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is six years of full-time work experience performing the *Essential Duties* of a Grade III Electrical/Instrumentation Technologist (listed below). You may also qualify by having four years of experience and holding any Grade II Plant Maintenance Certificate for two years, **OR** having four years of full-time experience and holding an Associate's degree in a related field, **OR** having three years of full-time experience and holding a Bachelor's, or higher, degree in a related field.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination **A**, **B**, **C**, or **D**. If you do not meet any of the combinations of experience and education, then you do not qualify for Grade III:

Combination	EDUCATION & CERTIFICATIONS +	EXPERIENCE
A	None	6 full-time in vocation*
B	Hold Grade II Plant Maintenance Certificate for 2 years	4 full-time years in vocation*
C	Hold an Associate's degree in a related field	4 full-time years in vocation*
D	Hold a BA/BS, or higher, degree in a related field	3 full-time years in vocation*

* experience must be in electrical/instrumentation technology, or other field closely related to water or wastewater plant electrical/instrumentation maintenance.

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties

Individuals certified as Grade III PM Electrical/ Instrumentation Technologists are expected to possess acceptable competency when performing the tasks that are necessary for lead or advanced level electrical/Instrumentation Technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade III

1. Supervises electrical instrumentation and power production systems staff to ensure division plans, goals, and objectives are met, including the development of recommendations regarding work organization, assignments, work schedules and staff training needs
2. Conducts staff training and develops written training manuals
3. Prepares performance evaluations and initiates disciplinary actions
4. Assigns and participates in the work of skilled subordinate staff who design, install, test, adjust, modify and maintain digital and logic circuitry, microprocessor controlled devices and elements, such as programmable logic controllers, process control equipment, telemetering devices, recorders, sensors, alarms, and controllers on water quality treatment process instruments and devices
5. Performs and instructs staff in the safe, effective and efficient methods of hand and power tool operations and maintenance, electrical system testing and meter calibration
6. Recognizes abnormally operating equipment and used advanced troubleshooting methods and skills to diagnose, analyze and recommend required repairs
7. Assists in budget preparation with recommendations to include personnel requirements, tools, equipment, contract services, warehouse spare parts and future plant and pump stations capital expenditures for equipment and repairs required
8. Performs the more complex corrective maintenance by inspecting equipment, checking voltage and amperage, tightening and cleaning

equipment and locating potential problems
9. Performs the more complex electrical circuit installation for additions or modifications by bending and installing conduit, pulling wire, wrings in circuit as shown on blueprints and testing systems for proper installations
10. Maintains and repairs electrical equipment at pump stations such as motors, switchgears, substations and control equipment
11. Generates power at pump stations during outages by connecting emergency generator to pump stations

Complexity Of Test Questions

At the Grade III level, certificate candidates are expected to have the knowledge, skill and ability to safely and effectively accomplish and coordinate complex tasks as listed in the *Essential Duties* above. Grade III candidates are also expected to be familiar with the Grade I Plant Maintenance and Grade II Electrical/Instrumentation knowledge, skills and abilities. Examinees will have to answer multiple choice questions that test application, analysis, and synthesis of the subject matter. The complexity of the questions will cover the abilities: to abstract in particular and concrete situations; to clarify and organize theories and ideas; and to put facts together to form new solutions.

Test Content Areas

The following list is an outline of Test Content Areas. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties* listed above. Since all of the Knowledge, Skills, or Abilities are required to perform the *Essential Duties* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are equally weighted on the test. Candidates should also be thoroughly familiar with the Grade I Plant Maintenance and Grade II PM Electrical/Instrumentation *Test Content Areas*.

Test Content Areas Grade III

301. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I, and Electrical Instrumentation Technology Grade II

Knowledge of:

302. Advanced electrical and instrumentation principles and methods, precision measuring devices, special and general electrical and instrumentation test meters, and gauges and current generators
303. Safe and proper use of electrical and instrumentation test equipment, power and hand tools
304. Federal, state and local safety orders and NFPA (National Fire Protection Association) 70E Regulations
305. Preventive maintenance and repair of electrical and instrumentation equipment related to power productions systems for large stationary internal combustion engines, pumps, centrifugal blowers and compressors
306. The operation and maintenance requirements of wastewater treatment plant and lift station equipment and motors

Skill to:

307. Establish and maintain effective working relationships
308. Communicate effectively both orally and in writing, in the English language

Ability to:

309. Use electrical and instrumentation test equipment and design basic electrical circuits and instrumentation control loops
310. Read, interpret and follow complex blueprints, electrical and instrumentation schematics, plans and drawings, equipment troubleshooting guides and parts lists
311. Accurately detect, diagnose and repair electrical and instrumentation equipment problems
312. Supervise, train and develop plant maintenance personnel
313. Read, interpret, and follow complex servicing requirements, including electrical and instrumentation testing and calibration routines

Grade IV Electrical/Instrumentation

Plant Maintenance Grade IV Certification is designed to demonstrate competency at the program manager level. More specifically, Grade IV certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of a management level Electrical/Instrumentation Technologist.

Eligibility Criteria For Taking The Test

The basic requirement is eight years of full-time work in Plant Maintenance (Electrical/Instrumentation). You may also qualify by having six years of experience and holding an Electrical/Instrumentation Technologist Grade III Certificate for two years, **OR** having six years of full-time experience and holding an Associate's degree in a related field, **OR** having five years of full-time experience and holding a Bachelor's, or higher, degree in a related field. All Grade IV candidates must also demonstrate at least one year of experience supervising the work of others.

Eligibility criteria are summarized in the table below. You may qualify by meeting either Education/ Experience Combination **A**, **B**, **C**, or **D**. If you do not meet any of the combinations of experience and

Combination	EDUCATION &	EXPERIENCE
A	None	8 years in vocation* with one of those years supervising others
B	2 years holding Grade III Electrical/ Instrumentation Technologist certificate	6 years in vocation* with one of those years supervising others
C	Hold an AA/AS, or higher, degree in a related field	6 years in vocation* with one of those years supervising others
D	Hold a Bachelor's, or higher, degree in a related field	5 years in vocation* with one of those years supervising others
* experience must be in electrical/instrumentation technology or other field closely related to water quality or wastewater plant maintenance.		

Qualifying With Your Education

Holding a college degree, or its equivalent, in a field related to your vocation will reduce the number of years required for your test (see the table above). Your degree must be in a field that is related to the certificate for which you are applying. If you are uncertain if your degree is related to your vocation, you should still include your degree information in your application. The Technical Certification Program Committee will determine if your degree qualifies. If it does not, you will be accepted for the next highest grade level for which you qualify. Associate's and Bachelor's degrees in technical fields are usually accepted. Degrees are evaluated on a case-by-case basis upon receipt of the application. College credit without a degree is not accepted unless it can be demonstrated that the credit is equivalent to a degree.

Essential Duties

Individuals certified as Grade IV Electrical/ Instrumentation Technologists are expected to possess acceptable competency when performing the tasks that are necessary for management level electrical/instrumentation technologists. These necessary tasks are known as the *Essential Duties*. The certification test measures knowledge, skills and abilities required to perform the *Essential Duties*.

Essential Duties for Grade IV

401. Essential duties identified on the Test Content Specifications for Plant Maintenance Grade I, and Electrical Instrumentation Technology Grade II and III
402. Initiates, plans, directs and oversees the sequence of operations for large and complex repair and construction work at water quality and wastewater treatment plants, pump stations, storm drainage stations, potable and other associated water systems
403. Coordinates staffing with operational and mechanical activities, directs the coordination of assigned work with appropriate personnel, reviews, preliminary design and specification, and in association with appropriate staff, makes recommendations involving modifications to facilities
404. Directs, coordinates and reviews the work plan for assigned electrical/instrumentation plant facility services and activities; assigns work activities and projects, monitors work flow; reviews and evaluates work products, methods and procedures; and meets with staff to identify and resolve problems
405. Establishes policies and procedures for operation and maintenance of complex water and wastewater electrical/ instrumentation treatment equipment, chemical handling systems and oxygen injection
406. Designs and implements training of crews in appropriate plant maintenance, construction, repair and safety principles to meet and

comply with national, federal, state, and local regulations
407. Schedules and directs computer based maintenance programs
408. Formulates, initiates and directs the operational parameters for facilities and equipment under manager's jurisdiction, including storm periods or emergencies
409. Approves time sheets, equipment, labor changes and assigns priority of work orders
410. Participates in the development and implementation of goals, objectives, policies and priorities
411. Selects, trains, motivates and evaluates personnel performance; and implements discipline and termination procedures, when required
412. Prepares and presents staff reports and other correspondence as appropriate and necessary
413. Designs and administers safety programs

Complexity Of Test Questions

At the Grade IV level, certificate candidates are expected to have the knowledge, skill and ability to administer, coordinate and manage complex programs described in the *Essential Duties*. Grade IV candidates are also expected to be familiar with the Grade I, II, and III Plant Maintenance Technologist knowledge, skills and abilities. Examinees will have to answer multiple choice questions that test analysis, synthesis and evaluation of the subject matter. The complexity of the questions will cover the ability: to clarify and organize theories and ideas; to put together facts to form new solutions; to make managerial level judgments.

Test Content Areas

The following list is an outline of *Test Content Areas*. Each content area is a Knowledge, Skill, or Ability that is required to perform the *Essential Duties* listed above. Since all of the Knowledge, Skills, or Abilities are required to perform the *Essential Duties,* they are all equally important in the demonstration of acceptable competency. Thus, all of the content areas listed below are approximately equally weighted on the test. Grade IV candidates will not be expected to demonstrate competency in all of the technical aspects of Plant Maintenance Grade I, and Electrical/Instrumentation Grades II and III. However it is expected that Grade IV candidates will be familiar enough with the *Essential Duties* and Test Content Areas of these lower grade level Plant Maintenance vocations to make informed management decisions.

Test Content Areas for Electr/Instr. Grade IV

400. Knowledge, skills and abilities identified on the Test Content Specifications for Plant Maintenance Grade I, and Electrical Instrumentation Grades II, and III

Knowledge of:

401. The methods, materials, equipment, and chemicals used in the maintenance, repair and construction of various types of mechanical, hydraulic, pneumatic, chemical, and electrical/instrumentation components in water quality treatment plants, complex pumping stations, potable water facilities, and chemical handling
402. Safety principles and state-OSHA NFPA (National Fire Protection Association) 70E and federal, state and local safety order requirements involved in all aspects of plant maintenance work, equipment usage, and confined space work performed
403. Leadership, supervisory principles and practices that include training, planning, budgeting and scheduling effective use of personnel, equipment and materials
404. Computer systems relevant to water quality treatment facilities
405. Pertinent federal, state and local laws, codes and regulations
406. Permit and regulatory requirements for the operation of a water quality facility
407. Principles of budget preparation and control

Skill to:

408. Establish and maintain effective working relationships with those contacted in the course of work, including a variety of government officials and the general public (30%)
409. Direct operations of all mechanical, hydraulic, pneumatic, and electrical and instrumentation equipment used in treatment plant operations (40%)
410. Communicate clearly and concisely, both orally and in writing in the English language (30%)

Ability to:

411. Supervise, direct and coordinate the work of staff
412. Hire, supervise, train and evaluate staff.
413. Interpret and explain applicable policies and procedures
414. Prepare clear and concise reports
415. Plan and oversee complex jobs, including the utilization of personnel, materials, and equipment
416. Interpret and explain blueprints, specifications, and maps
417. Prepare and communicate budget information.

Sample Test Questions

Sample Test Questions
The following sample test questions are provided to help you become familiar with the multiple choice format. The sample questions reflect only a portion of the subject matter covered on the test. For each question, choose the single most correct answer. An answer key is given at the end of this section.

Grade I Plant Maintenance

1. To recess a hole for a fillister-head screw you must:

    a) countersink.
    b) counterbore.
    c) spot fact.
    d) center drill.

2. Which tool is used when measuring screw pitch?

    a) Ruler
    b) Thread gage
    c) Dial indicator
    d) Slide calipers

3. A concrete slab needs to be poured. The rectangular slab is to be 17 feet long and 13 feet wide with a depth of 4 inches. How many cubic yards of concrete will be needed?

    a) 73.67 cubic yards
    b) 32.74 cubic yards
    c) 2.73 cubic yards
    d) 5.46 cubic yards

Grade II Mechanical Technologist

1. A nylon faced hammer may be used in equipment assembly to:

    a) prevent electrical shock.
    b) reduce hammer replacement costs.
    c) reduce rebound or bounce like a regular hammer.
    d) prevent damage to surfaces that are struck.

2. Which of the following most affects valve life?

    a) Preventative maintenance
    b) Valve spring strength
    c) Size of drive motor
    d) Drive motor horsepower

3. The discharge rate of a piston-type pump:

    a) is constant as the main drive RPM changes.
    b) is constant at a constant speed.
    c) varies inversely with head.
    d) varies with the total dynamic head.

Grade III Mechanical Technologist

1. A tank measuring 8 feet high and 10 feet in diameter is filled with treated water to a depth of 5.11 feet. How many gallons of water are in the tank?

    a) 1926 gallons
    b) 3000 gallons
    c) 12002 gallons
    d) 7681 gallons

2. A supervisor who observes one of his or her subordinates in an unsafe activity should:

    a) correct the employee at once.
    b) wait until the behavior is observed again.
    c) document the incident and include it in the employee's annual review.
    d) wait until the next shop meeting to correct the employee so everyone can benefit.

3. ***Part A*****:** What size motor is needed to pump 0.792 MGD against 108.23 PSI?
Part B**:** What is the cost per 30 day month to operate this pump if the pump runs an average of 5 hours per day and the cost per KwH is 19.5¢?

    a) Answer to *Part A* is 35 HP
    Answer to *Part B* is $764

    b) Answer to *Part A* is 15 HP
    Answer to *Part B* is $327

    c) Answer to *Part A* is 35 HP
    Answer to *Part B* is $2546

    d) Answer to *Part A* is 15 HP
    Answer to *Part B* is $1091

Grade II Electrical/Instrumentation

1. When a 100-watt, 120-volt lamp burns constantly for 8 hours at rated voltage, the energy used is:

    a) 800 watt hours.
    b) 960 watt hours.
    c) 12,000 watt hours.
    d) 96,000 watt hours.

2. If two 4.8 ohm resistors are connected in parallel, the resulting resistance will be:

    a) 3 ohms.
    b) 2.4 ohms.
    c) 1.2 ohms.
    d) 0.6 ohms.

3. In any typical motor control scheme the device which is first in the circuit is the:

    a) starter coil
    b) indication lamp
    c) fuse
    d) lock-out stop button

4. When entering a confined space, what must be tested?

    a) Moisture level
    b) Noise level
    c) UV level
    d) Oxygen and LEL levels

5 . A tank 40 feet in diameter and 20 feet high is filled to 18 feet with oil that has a specific gravity of 0.91. What is the gauge pressure at the bottom of the tank in PSI?

    a) 7.09
    b) 7.79
    c) 7.88
    d) 8.56

6. Five lights are connected in parallel and fed by a six volt 100 amp hour battery. Each light is a sixty watt lamp. How long could this battery keep these lamps lit?

    a) 1.0 hr.
    b) 1.5 hr.
    c) 2.0 hr.
    d) 0.25 hr.

7. A ground connection should be made:

    a) before the current carrying wire is connected.
    b) after the current carrying wire is connected.
    c) only if power may be accidentally interrupted.
    d) only when an extension cord is used.

8. If a #12 wire will safely carry 20 amps at 120 volts, what will it carry at 240 volts?

    a) 10 amps
    b) 20 amps
    c) 15 amps
    d) 30 amps

Grade III Electrical/Instrumentation

1. To test and calibrate a polyphase watt-hour meter using a single phase a.c. supply, the best method is to connect the :

    a) voltage coils in series, current coils in parallel.
    b) current coils in parallel, voltage coils in parallel.
    c) current coils in series, voltage coils in parallel.
    d) voltage coils in series, current coils in series.

2. A pumping station that has two 100 HP pumps that operate 20% of the time each, 1½ HP sump pump that operates 2 hours a day, 5100 watt lights on a timer that burn from 6:00 P.M. to 5:00 A.M. and a 1 HP air compressors that operates a total of 3 hours a day, cost 8½ ¢ per KWH to operate. What is the cost per month (30 days) for power to run this lift station?

    a) $10,007.50/mo
    b) $9080.20/mo
    c) $9932.50/mo
    d) $1980.68/mo

3 . In a capacitive circuit what is the relationship of the current to the voltage?

    a) Current leads voltage
    b) Current in phase with voltage
    c) Current and voltage both 90° out of phase
    d) Current is 120° out of phase with voltage

4 . What is the brake horsepower of a pump designated to deliver 5 cubic feet per second of water at a total head of 200 PSIG with an efficiency of 85%?

a) 240
b) 308
c) 328
d) 400

5 . The formula to calculate the Inductive Reactance of a coil is:

a) $\frac{1}{2\ \pi\ FL}$

b) $\frac{1}{2\ \pi FC}$

c) $2\pi\sqrt{FL}$

d) $2\pi FL$

6. Workers compensation laws have been enacted so that workers injured while on the job may receive benefit payments:

a) only if the injury was the employer's fault
b) only if the injury was the employee's fault
c) only if negligence on the part of the employer can be proved
d) regardless of whose fault the injury was

7. Why is it necessary to limit the current carried by a wire?

a) To achieve maximum economy
b) To guard against the danger of fire
c) To increase the voltage factor
d) To increase the demand factor

8. A heating appliance rated at 1000 watts at 240 volts is connected to 208 volts. What is the wattage?

a) 1153.8 watts
b) 866.6 watts
c) 1000 watts
d) 751.1 watts

Grade IV Electrical/Instrumentation and Grade IV Mechanical Technologist

1. A senior supervisor institutes a policy of minimizing the amount of information passed onto subordinates since it is felt that they are too burdened with details. This practice is:

a) Improper: The subordinates lack information which may be necessary to properly perform their duties.
b) Proper: This leadership strength is increased by the degree to which subordinates turn to the supervisor for guidance.
c) Improper: The senior supervisor is trying to carry too many responsibilities.
d) Proper: It is part of the job for the senior supervisor's job to act as a buffer for subordinates and give them only the information they need to competently perform the job.

2. Potential difference in electricity measures:

a) current.
b) power.
c) voltage.
d) resistance.

3. Most building codes and specifications require ASTM (American Society for Testing and Material) classifications for mortar used. The classification for different mix is which of the following?

a) Types M, S, N, or O
b) One part cement, ½ part hydrated lime, 1 part sand
c) Grade 2, 3, 4, or 5
d) Grade A, B, C, or D

4. You have recently observed a worker, under your supervision, who quickly loses his temper with other co-workers, uses foul language, and many times refuses to cooperate with others. At times it appears to you that the last place he wants to be is at work and it shows in his performance. You find this recent behavior peculiar since it is not typical of him. You consider the following options:

I. Urge him to seek professional counseling or medical help if appropriate.

II. Call a shop meeting to discuss personal attitudes that are not acceptable in the workplace.

III. Hold a private meeting with the

employee and tell him that his behavior is very immature and that his personality is too abrasive to his fellow employees.

IV. Document the behavior.

V. Terminate the employee for insubordination.

VI. Call him into a private meeting and let him know that he needs to speak more respectfully to his co-workers and supervisor.

The best course of action to resolve this problem would be to:

a) follow Option I then Option II.
b) simply follow Option IV and wait to see if the problem persists.
c) follow option VI then Option IV, then decide what to do next if the problem persists.
d) follow option VI then Option IV, then warn him that you will follow Option V if you and his co-workers continue to feel uncomfortable around him.

5. Autocratic leadership is one supervisory style. Which of the following describes an autocratic supervisor's style?

a) One that uses centralized power and enjoys giving orders.
b) One that allows the group of members to work as they see fit.
c) One that allows the followers to share in the decision making process.
d) One that utilizes the delegation of power.

6. According to the scheduling chart below, how many total hours did all employees work during this week?

X = regular day off
A = 8:00am to 5:00pm/8-hour shift
B = 5:00pm to 9:00pm/4-hour shift

a) 154 hours
b) 168 hours
c) 148 hours
d) 182 hours

Employee	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Sarah	X	X	A	A	A	A	A
Javier	A	X	X	B	B	A	A
Max	A	A	X	X	A	A	A
Pam	B	B	B	X	X	X	X
Pat	X	A	A	A	X	X	X

Sample Test Question Answer Key

GRADE I PLANT MAINTENANCE

1. b
2. b
3. c

GRADE II MECHANICAL TECHNOLOGIST

1. d
2. b
3. b

GRADE III MECHANICAL TECHNOLOGIST

1. b
2. a
3. a

GRADE II ELECTRICAL/INSTRUMENTATION

1. a
2. b
3. c
4. d
5. a
6. c
7. a
8. b

GRADE III ELECTRICAL/INSTRUMENTATION

1. c
2. d
3. a
4. b
5. d
6. d
7. b
8. b

GRADE IV ELECTRICAL/INSTRUMENTATION
and
GRADE IV MECHANICAL TECHNOLOGIST

1. a
2. c
3. a
4. c
5. a
6. c

Selected References

The following table lists references that may be useful when studying for the certification test. It provides information for primary and supplementary study references. Primary study references are recommended as the best sources for studying for the certification test. Supplementary study references are recommended as sources that will help to further your understanding of the subject matter beyond the primary references.

For each reference a "**P**" indicates **P**rimary reference and an "**S**" indicates a **S**upplementary reference. Check the Grade column that corresponds to the grade level you will be taking to determine if a reference is **P**rimary or **S**upplementary. Blank boxes indicate that the reference is not appropriate for that grade level.

Reference	PM 1	M 2	M 3	E/I 2	E/I 3	E/I 4 & M4
"American Electrician's Handbook" Croft, Terrell, and Wilford I. Sumners, Mc Graw Hill. ISBN: 0070139369 www.mcgraw-hill.com or Amazon.com				S	S	
"Applied Math for Wastewater Plant Operators" Joanne Kirkpatrick Price, CRC Press, 1-800-272-7737 www.crcpress.com	S					
"Arc Welding Operations" TPC Training Systems, Buffalo Grove, IL. 800-837-8872. www.tpctraining.com			P			
"Audel (Mechanical Trades Pocket Manual)," 3rd Ed., Nelson, Carl A., www.amazon.com or other online booksellers	S	S	S			
"Confined Space Entry", WEF Publication, 1998 Edition", Water Environment Federation, 601 Wythe Street, Alexandria, VA. 22314-1994, Phone: 1-800-666-0206.	P	P	P	P	P	P
Plant Maintenance, Mechanical Technologist, and Electrical/ Instrumentation Study Guides (2001) CWEA 510-382-7800 www.cwea.org	S			P	P	S
"Instrumentation and Computer Integration of Water Utility Operations: Cooperative Research Report" (1993), American Water Works Association, Denver. 1-800-926-7337				S	P	
"Electricity One Seven", ISBN: 0139178570 Difficult to find. Try Amazon.com				S	S	S
"Instrumentation in Wastewater Treatment Facilities: MOP21" (1993), Water Environment Federation, Alexandria VA. 800-666-0206.				P	P	
"Maintaining Wastewater Equipment", TPC Training Systems, Buffalo Grove, IL. 800-837-8872. www.tpctraining.com		P				
"Making Measurements" TPC Training Systems, Buffalo Grove, IL. 800-837-8872. www.tpctraining.com	P	S	S		S	P
"Management and Supervision for Working Professionals, Vol.I-II." Koren, Herman . National Environmental Health Association Lewis Publishers, New York. ISBN: 1566702038			S		S	S
"The Math Text for Water and Wastewater Technology" Second Edition, Wrights Training, P.O. Box 515, Elmira, CA. 95625-0515. (707) 448-3659 www.wrights-trainingsite.com	P	P	P	P	P	P
"NEC 1997 Code Book" or "1999 Code", National Fire Protection Association, www.amazon.com	S	S	S	S	S	S
"Operation Wastewater Treatment Plants", Volume 2, 4th ed., Kenneth Kerri, Office of Water Programs, California State University Sacramento, 6000 J Street, Sacramento, CA. 95819-6025, Phone: (916) 278-6142. Chapter 15	S	S		P	S	

Reference	PM 1	MT 2	MT 3	E/I 2	E/I 3	E/I 4 & M4
"Pneumatic Trouble Shooting" TPC Training Systems, Buffalo Grove, IL. 800-837-8872.	S	P	S			
"Pump Handbook", McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY. 10020, 1-800-2-MCGRAW www.mcgraw-hill.com		S				
"Pumps & Pumping", Skeet Arasmith, ACR Publications Inc., 1298 Elm Street SW Albany, OR. 97321, (800) 433-8150 www.acrp.com		S	P			
"Supervisor's Guide to Safety and Health Programs", Water Environmental Association, 601 Wythe Street, Alexandria, VA. 22314-1994, 1-800-666-0206. www.wef.org			S		P	S
"Manage for Success: Effective Utility Leadership Practices", Office of Water Programs, California State University Sacramento, 6000 J Street, Sacramento, CA. 95819-6025, (916) 278-6142. www.owp.csus.edu			P		P	P
"Supervisory Management in the Water/Wastewater Field", Michigan State University, Self Study Course, 3535 Forest Rd. Lansing, Michigan 48910, 1-800-356-5705 www.vu.msu.edu			S		S	S
"Working With Metals" TPC Training Systems, Buffalo Grove, IL. 800-837-8872. www.tpctraining.com		P	P			

For information about obtaining these publications, use the website or phone number listed in the reference. If no website or phone number is listed, contact the publishing agency directly or contact your local library or bookstore.

This reference list is intended to assist certificate candidates in preparation for the Plant Maintenance certification tests. Use of these references does not guarantee successful completion of the test. There may be other publications that may be helpful to candidates preparing for the test. CWEA encourages candidates to identify and utilize other resources in preparing for the test.

Preparing For Your Test

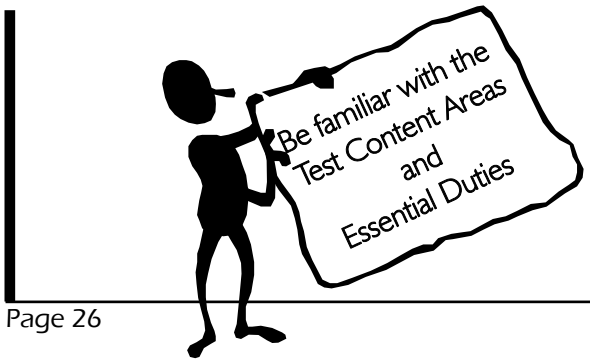
This section addresses a few possible methods for preparing for the certification test. Since you are most familiar with your own abilities, you are responsible for determining the best method for preparing for your certification test. Following the suggestions in this section does not guarantee you will pass the certification test.

Determining Your Preparedness: An individual's preparedness for the certification test depends on a number of things, including amount of practical experience in the vocation and years of education. If you are unsure how prepared you are for the test, review the *Essential D*uties and *Test Content Areas* for the test that you are considering. If you are not familiar with most of the *Essential Duties* and *Test Content Areas,* you should consider reviewing some of the material in the references listed for that grade level. You may also want to consider applying for a lower grade level if appropriate.

Using The Selected References: After evaluating how well prepared you are for the written test you may want to review some of the Selected References. The references in this list may be used to review those Test Content Areas that you are not familiar with or those for which you have little background. Well prepared candidates may only have to brush up on a few topics while those less prepared may have to study extensively.

Study Sessions: CWEA Local Sections host at least two study sessions in various parts of California. All applicants will be mailed the date and location of the nearest preparation classes. Usually these classes are given about two months before the test date and last a full day with Grades I and II material covered in the morning and Grades III and IV covered in the afternoon.

Using the Essential Duties and Test Content Areas as a Guide to Your Study: The Essential Duties (EDs) are a basic outline of the test subject matter. You can use the EDs as your study guide by referring to the EDs in the primary Selected References. As you study you will find that the TCAs are related to the EDs. Each test question is written to address at least one TCA and its related ED.



FAQs

Frequently **A**sked **Q**uestions

Question: Is it required that I begin at the Grade I level then work my way up from there to higher levels?
Answer: No. You may take any test that you qualify for with your education and experience. However, if you are just starting out, you can see by the education and experience requirements that you can work your way up the grade levels faster if you become certified at Grade I then achieve each successive certification as soon as you get the required education and experience.
Question: If I take a Grade II, III, or IV test will I have to know the Test Content Areas for the lower level tests?
Answer: Yes. The subject matter for each test builds on the subject matter for those tests below its grade level.Thorough knowledge of the Test Content Areas for the grade level that you are taking is most important to your preparation, but you should expect questions from any of the lower grade levels.
Question: Is continuing education required to renew my certification?
Answer: Yes. For any certificate earned on or after July 2002, you need to obtain 12 hours of continuing education every two years. For more information, visit www.cwea.org, or feel free to call the CWEA office.
Question: How long is the test?
Answer: All tests have about 75-100 questions and 3 hours are given for completion.
Question: Can I take more than one certification test at once?
Answer: Yes, but you can only take up to two at a time, and they cannot be in the same discipline. You will be given a total of three hours to complete both tests.
Question: How do I get a receipt showing I paid for the test?
Answer: A receipt is sent to all applicants who have paid their fees about one month after the application deadline. Hold on to this receipt until the certification process is over in case you have to submit it to your employer for reimbursement.
Question: If I am applying for a Grade IV test do I need to be a supervisor?
Answer: No, you just need to have about one year of supervision experience. You do not have to hold the title of "Supervisor."
Question: Does my qualifying experience need to be at a wastewater treatment plant?
Answer: Not necessarily. Similar experience maintaining a water treatment facility is also acceptable as long as it generally fits the *Essential Duties*. Experience from other industries is also acceptable if it generally fits the *Essential Duties*.

Plant Maintenance
Math Formulas and Conversion Factors*

1 cubic foot = 1,728 cubic inches
1 day = 1,440 minutes
1 horsepower = 33,000 foot-pounds/minute
1 horsepower = 42.45 Btu/minute
Coefficients of thermal expansion =
0.00000633/F° for steel
0.00001/F° for brass
1 psi = 2.31 feet of water
1 MGD = 1.55 cubic feet/second
1 therm = 100,000 Btu

1 cubic foot of water weighs 62.43 pounds
1 cubic foot/second = 449 gallons/minute
1 kilowatt = 1000 watts
1 Btu = 778 foot-pounds
1 cubic foot = 7.48 gallons
1 gallon of water weighs 8.34 pounds
1 MGD = 694 gallons/minute
1 horsepower = 746 watts
1 watt = 3.412 Btu/hour

$\pi = 3.14159$

$$Area_{triangle} = \frac{base \times height}{2}$$

$$Circumference_{circle} = \pi \times diameter$$

$$Area_{circle} = \pi \times radius^{2}$$

$$Volume_{rectangular\ solid} = length \times width \times height$$

$$Volume_{triangular\ solid} = \frac{base \times height \times length}{2}$$

$$Volume_{cylinder} = \frac{\pi}{4} \times diameter^{2} \times height$$

$$Perimeter_{Rectangle} = 2 \times (length + width)$$

$$Area_{circle} = \frac{\pi}{4} \times diameter^{2}$$

$$Area_{rectangle} = base \times height$$

$$Area_{circle} = 0.7854 \times diameter^{2}$$

$$\frac{Big}{Little} = \frac{Fast}{Slow}$$

$$Water\ horsepower = \frac{flow \times total\ head \times specific\ gravity}{3960}$$

$$Brake\ horsepower = \frac{water\ horsepower}{efficiency}$$

$$Hydrostatic\ force = column\ area \times column\ height \times fluid\ density$$

$$Thermal\ expansion = coeff.of\ thermal\ expansion \times length \times \Delta T$$

$$Energy = power \times time$$

$$Efficiency = \frac{work\ output}{work\ input}$$

$$3\,phase\ amperes = \frac{746 \times horsepower}{1.732 \times volts \times efficiency \times power\ factor}$$

$$3\,phase\ volt\ amperes = volts \times amperes \times 1.732$$

**These conversions and formulas are given on all Plant Maintenance Tests*

Test Application Dates and Deadlines	
Application Deadline	Test date
April 31, 2007	July 28, 2007
October 31, 2007	January 26, 2008

Other CWEA Certificate Programs

- Biosolids Land Application Management
- Collection System Maintenance
- Environmental Compliance Inspector
- Laboratory Analyst
- Industrial Waste Treatment Plant Operator

For more information about these programs call CWEA at 510-382-7800, or visit our web site at http://www.cwea.org

California Water Environment Association
7677 Oakport Street, Suite 525
Oakland, CA 94621-1935

Have a question?
Give us a call at (510) 382-7800.